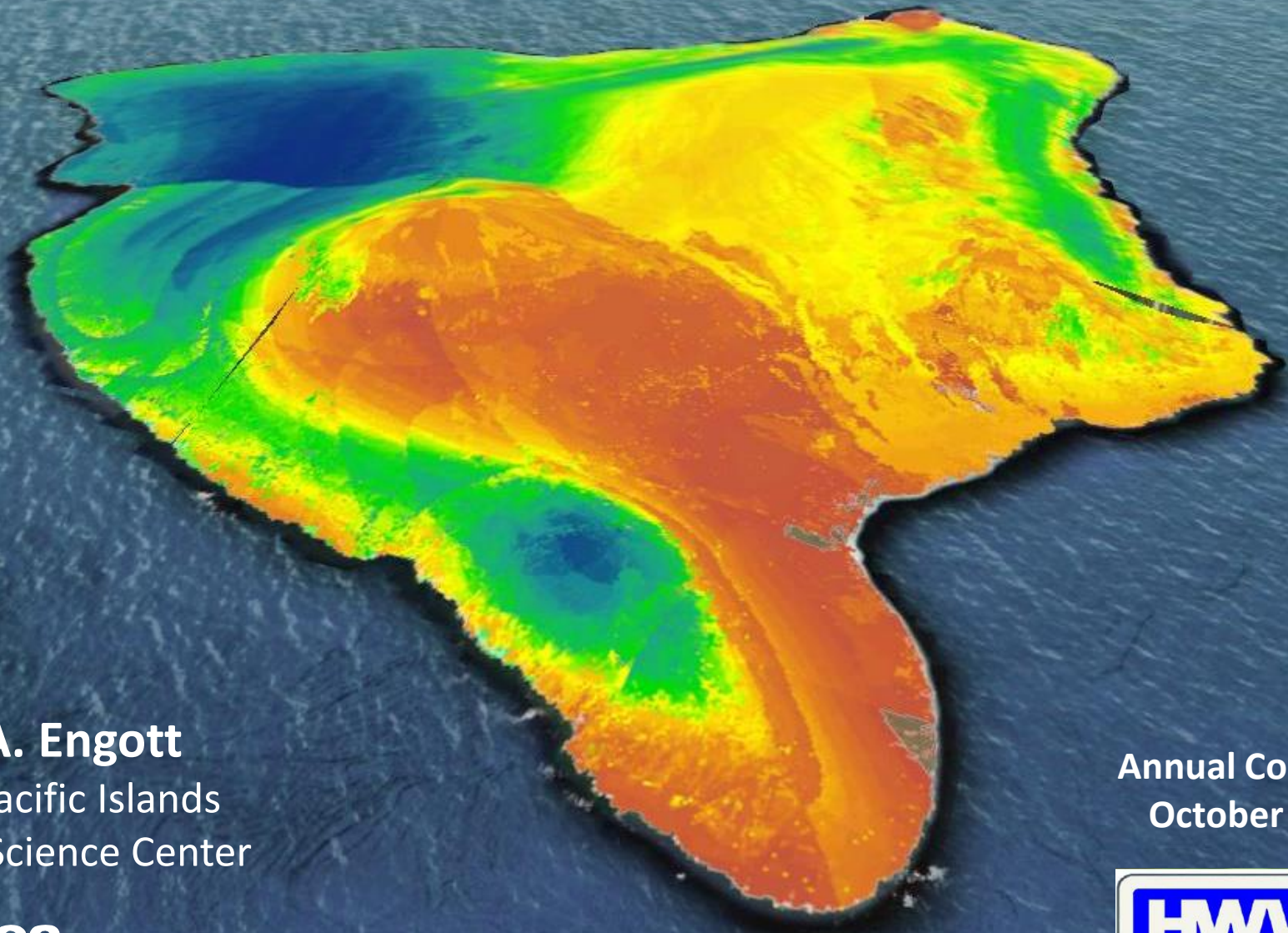


Improvements to Water-Budget Model for Estimating Groundwater Recharge in Hawaii



John A. Engott
USGS Pacific Islands
Water Science Center

HWWA
Annual Conference
October 24, 2013

Overview

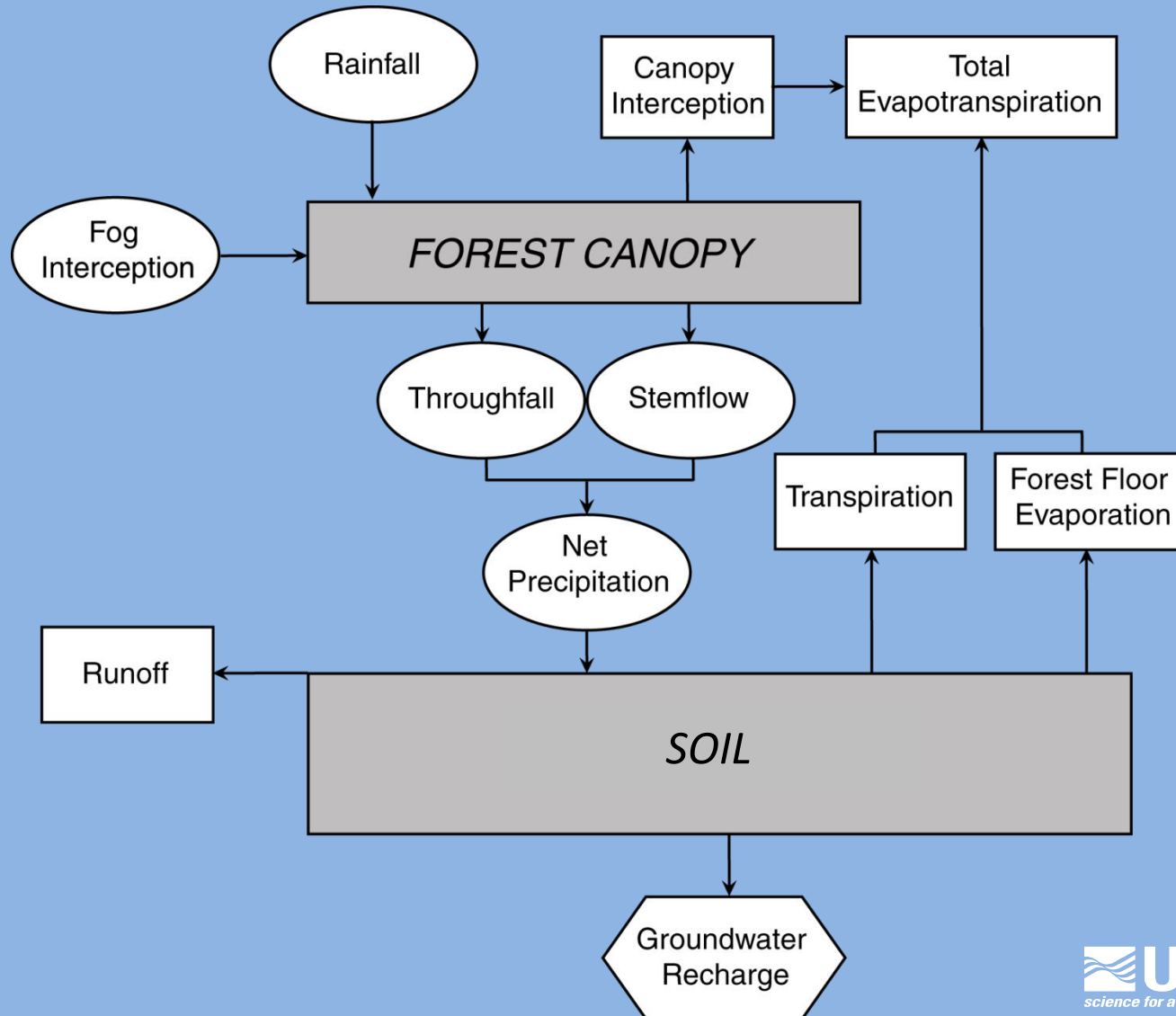
- Importance of recharge
- Water-budget basics
- Updated datasets and improved methods
- Climate and land-use change scenarios
- Current projects

Why is Recharge Important?

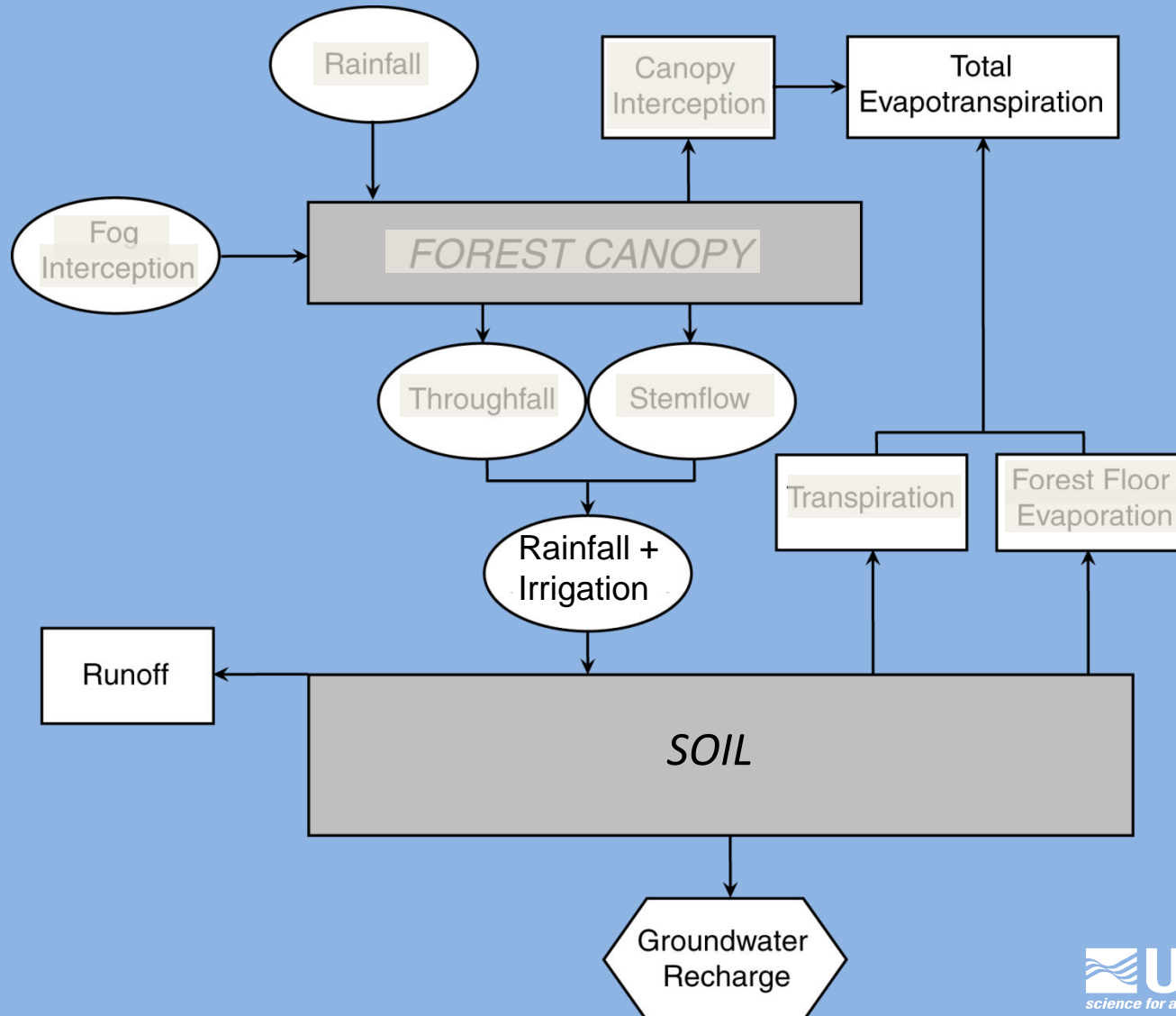
- Recharge is used by CWRM in determining sustainable yields
- Recharge is used in numerical groundwater models to assess groundwater availability

Water-Budget Basics

Water Budget for Forested Areas



Water Budget for Unforested Areas



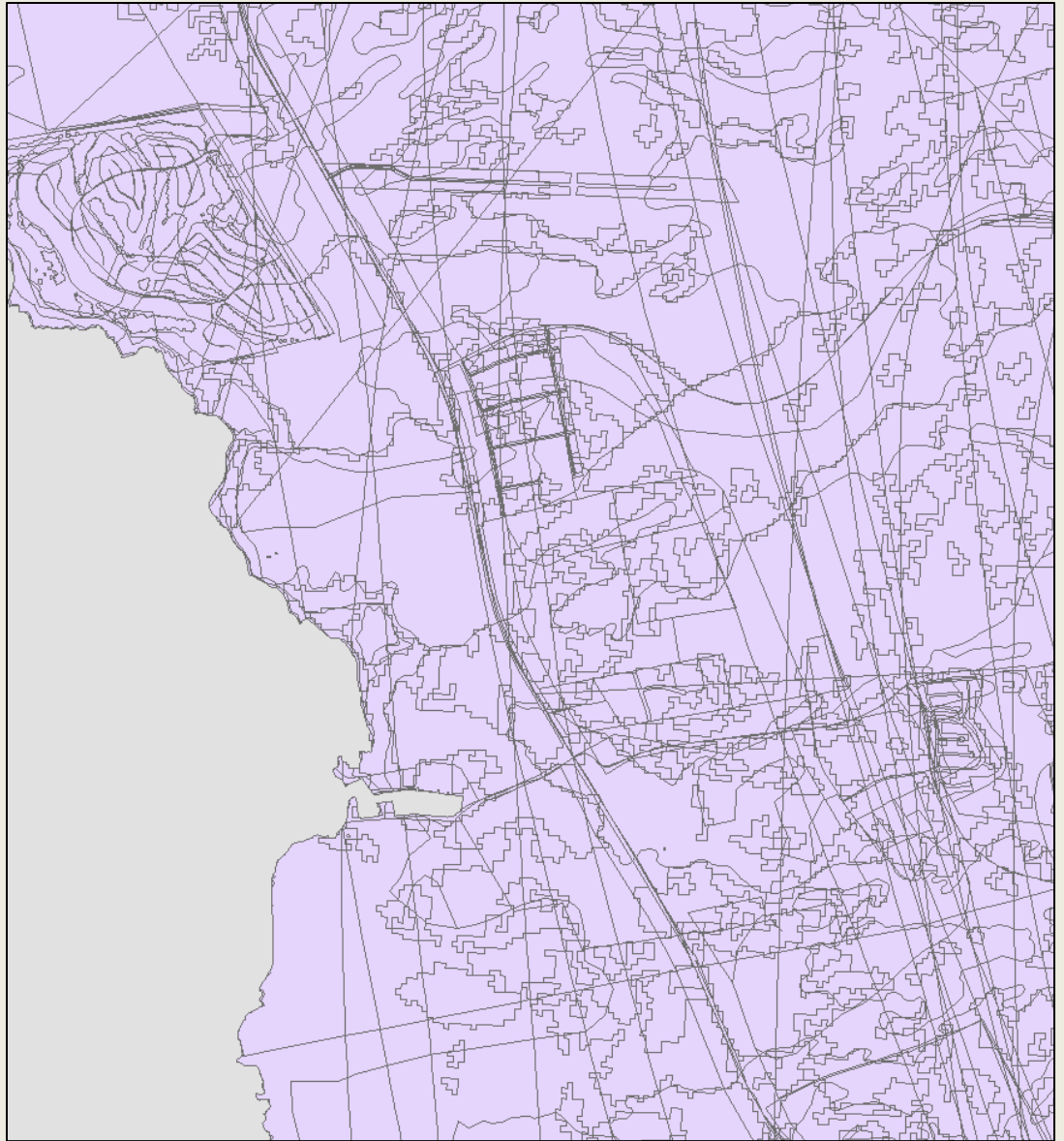
Water-Budget Subareas

Water budget calculated independently on subareas

Subareas have unique sets of input parameters (rainfall, fog, irrigation, reference ET, land cover, soil, etc.)

GIS data layers are merged to determine subareas

467,805 subareas in the Big Island water budget



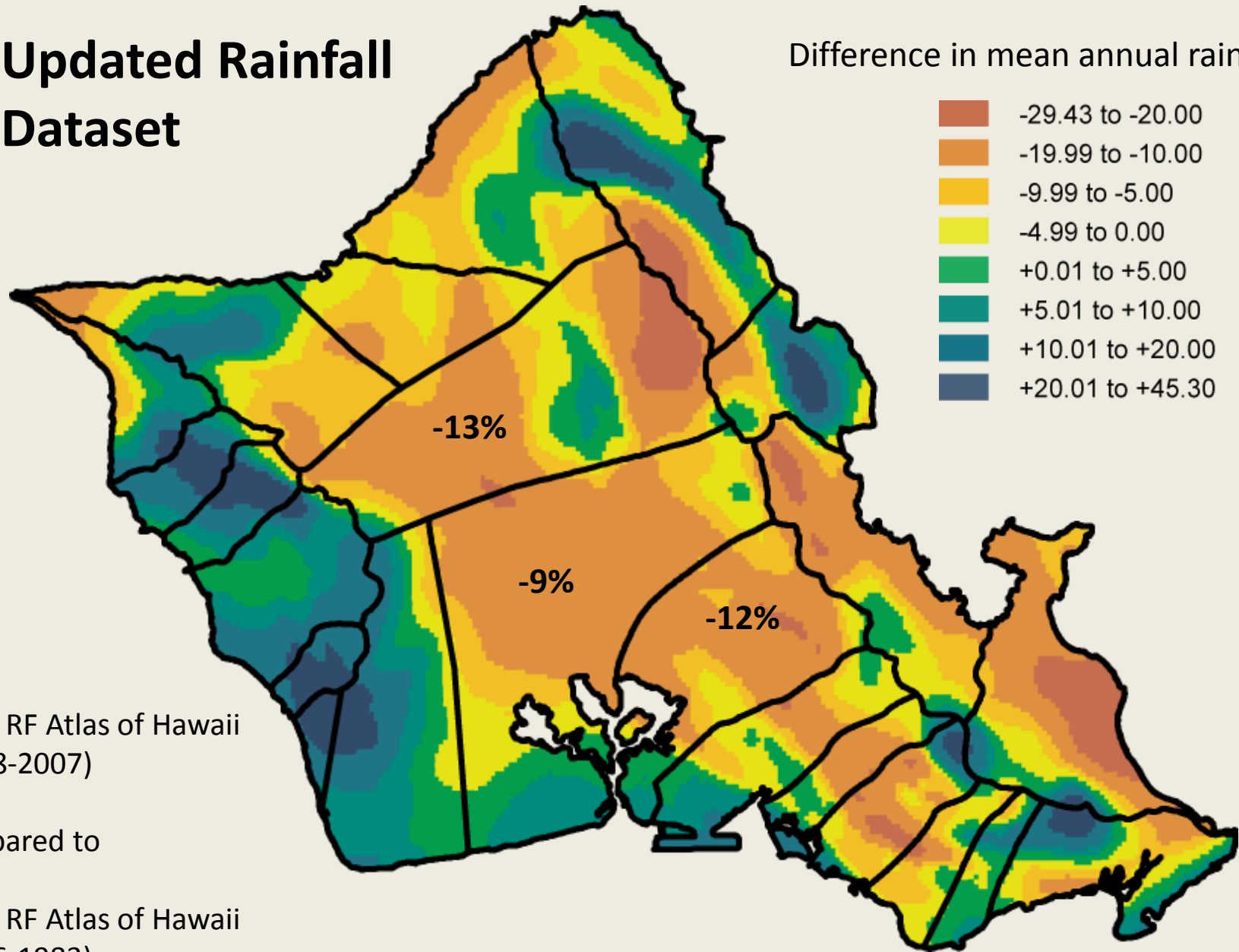
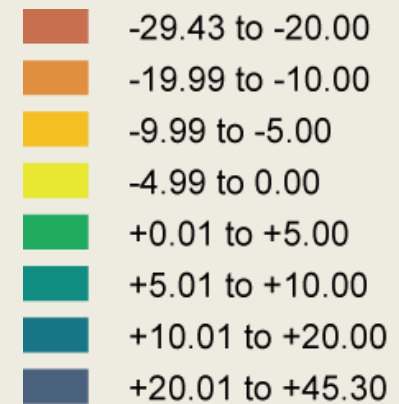
Updated Datasets and Improved Methods

Updated Rainfall Information

- Rainfall Atlas of Hawaii (2011) from Geography Dept, UH-Manoa (T. Giambelluca and others)
 - 1978-2007 base period
- Gridded dataset of historical monthly rainfall (A. Frazier and others) *unpublished*
 - 1920-2007 (soon to be through 2010)
- New rainfall datasets use spatial interpolation techniques instead of professional hand contouring

Updated Rainfall Dataset

Difference in mean annual rainfall (%)



2011 RF Atlas of Hawaii
(1978-2007)

compared to

1986 RF Atlas of Hawaii
(1916-1983)

Islandwide: 8% less rainfall

Updated ET Information

- New ET datasets are currently being developed by the Geography Dept at UH-Manoa (T. Giambelluca and others)
- ET estimates are based on spatially interpolated meteorological data and land-cover properties
- Previous ET estimates largely relied on pan-evaporation data from the old sugarcane days

Updates for Forested Areas

- Recent studies in tropical rainforest support:
 - separation of ET processes in forests into canopy evaporation, transpiration and ground evaporation
 - differentiation between fog and non-fog forest
- Canopy evaporation estimated using a model that incorporates canopy cover and storage capacity (Gash model)

Updated Runoff Method

- Develop regression equations using data and properties in gaged basins
- Data and properties chosen as candidates include:
 - Rainfall intensity
 - ET
 - Soil properties
 - Slope
 - Aspect
- Statistically test and choose best equations
- Use regression equations in ungaged areas

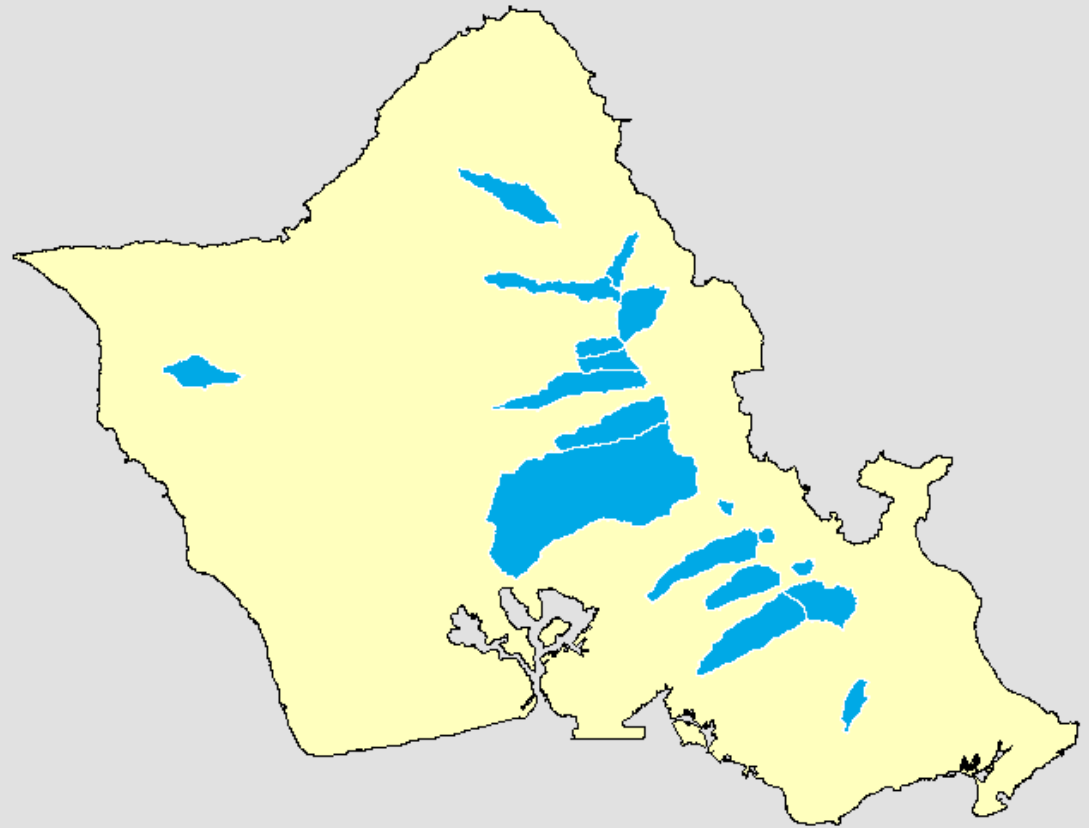
Runoff Estimation

In gaged drainage basins with adequate data, runoff estimated using runoff-to-rainfall ratios

In other areas, runoff estimated using regression equations

Only 11% of Oahu land area is in gaged drainage basins with adequate data to estimate runoff

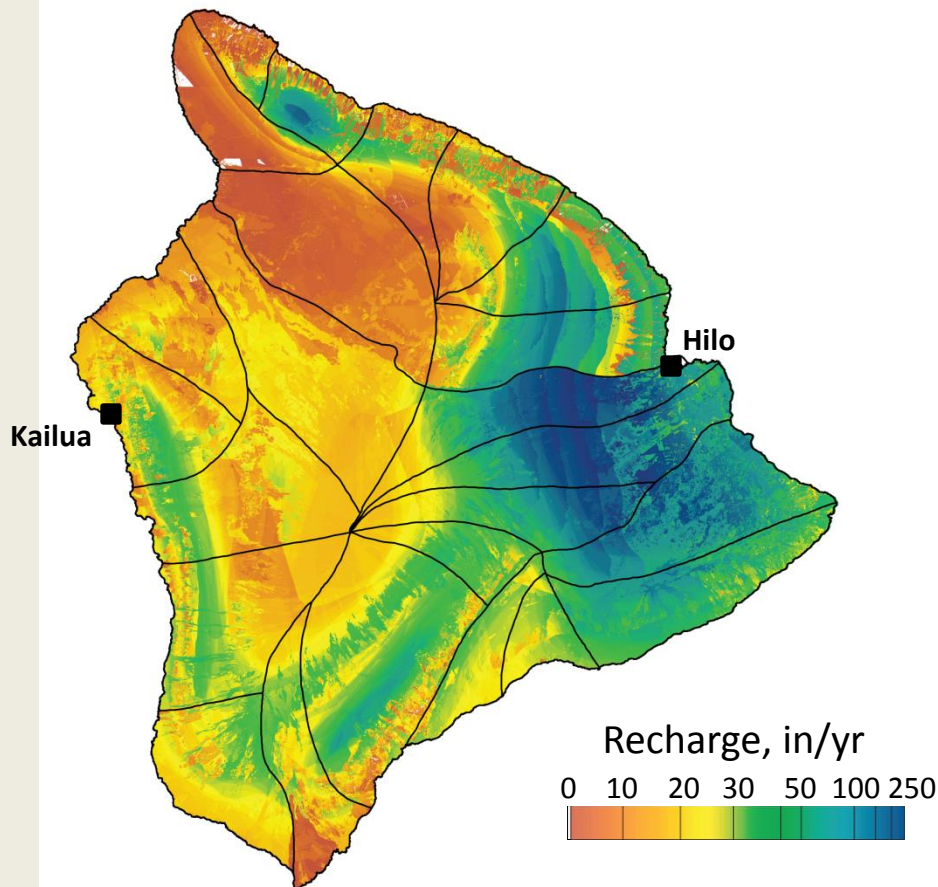
11 of the 18 streamgages with adequate data have been discontinued



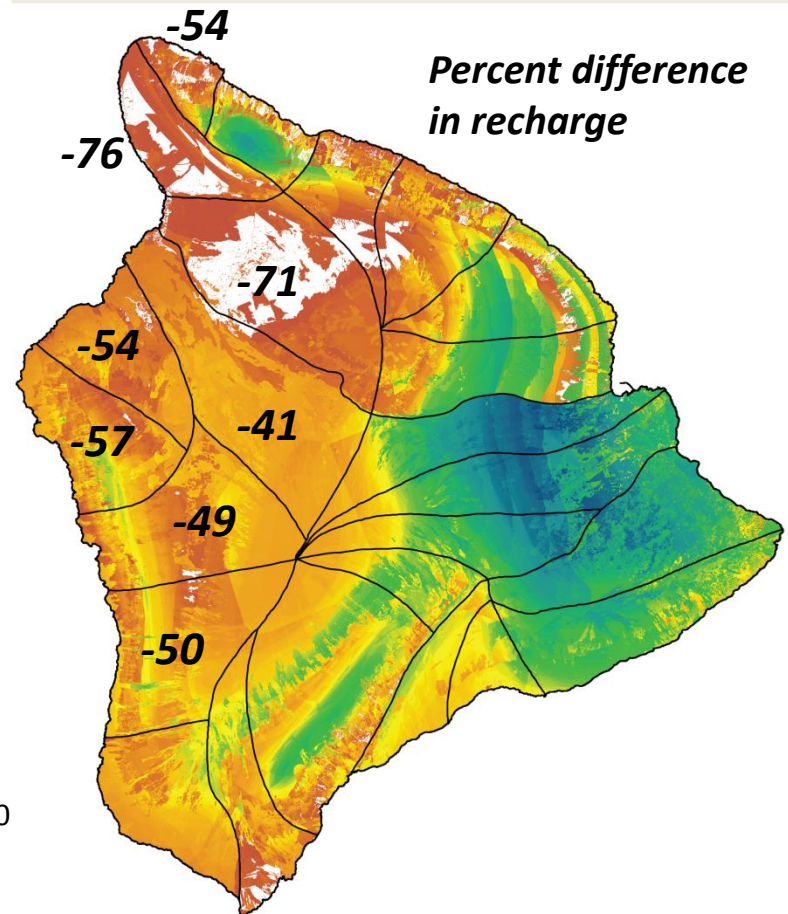
Climate and Land-Use Change Scenarios

Effect of Drought on Recharge for the Big Island

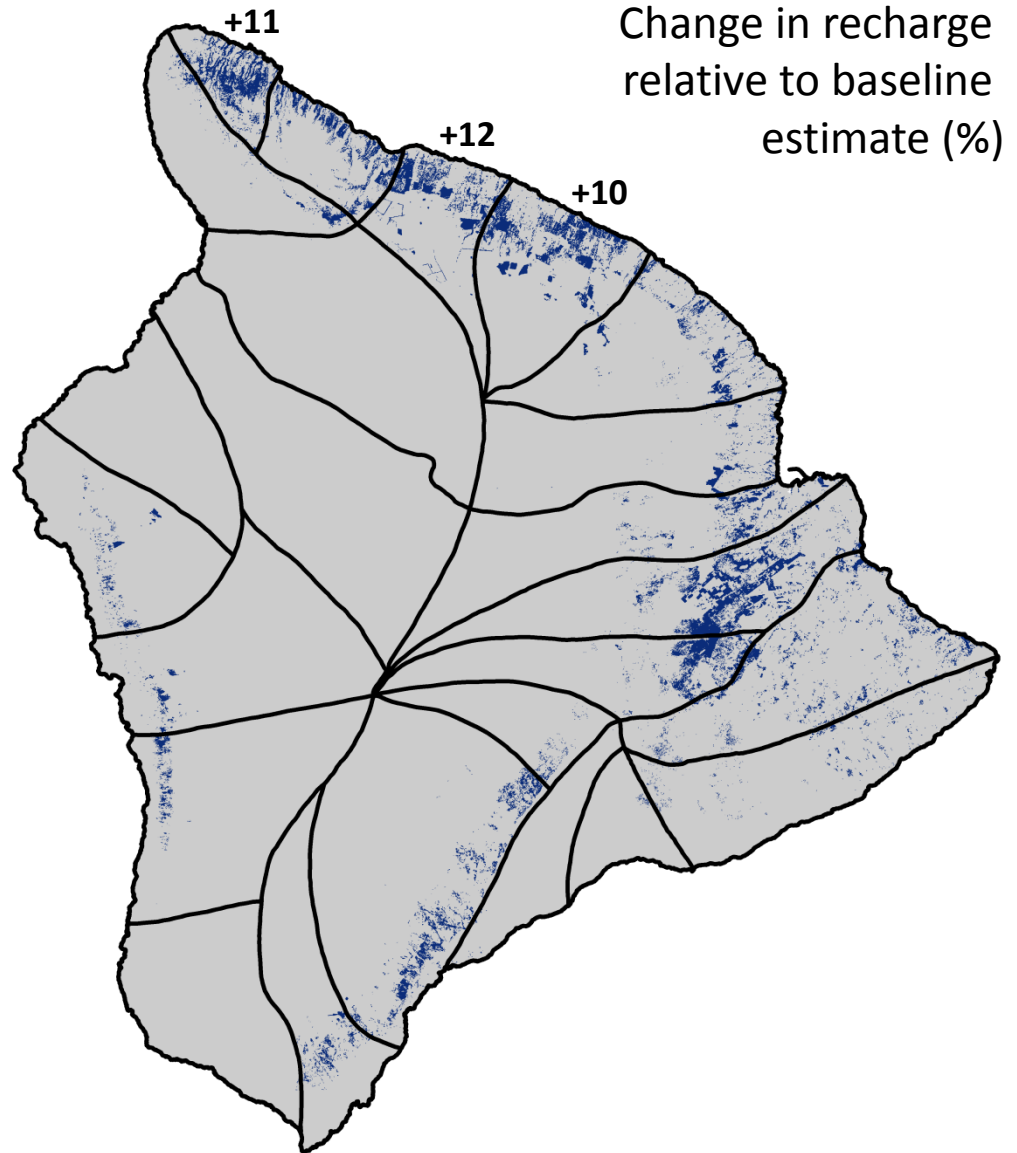
Baseline Recharge
(1916-1983 mean rainfall)



Drought-Period Recharge
(lowest 5-year rainfall period)



Alien to Native Forest

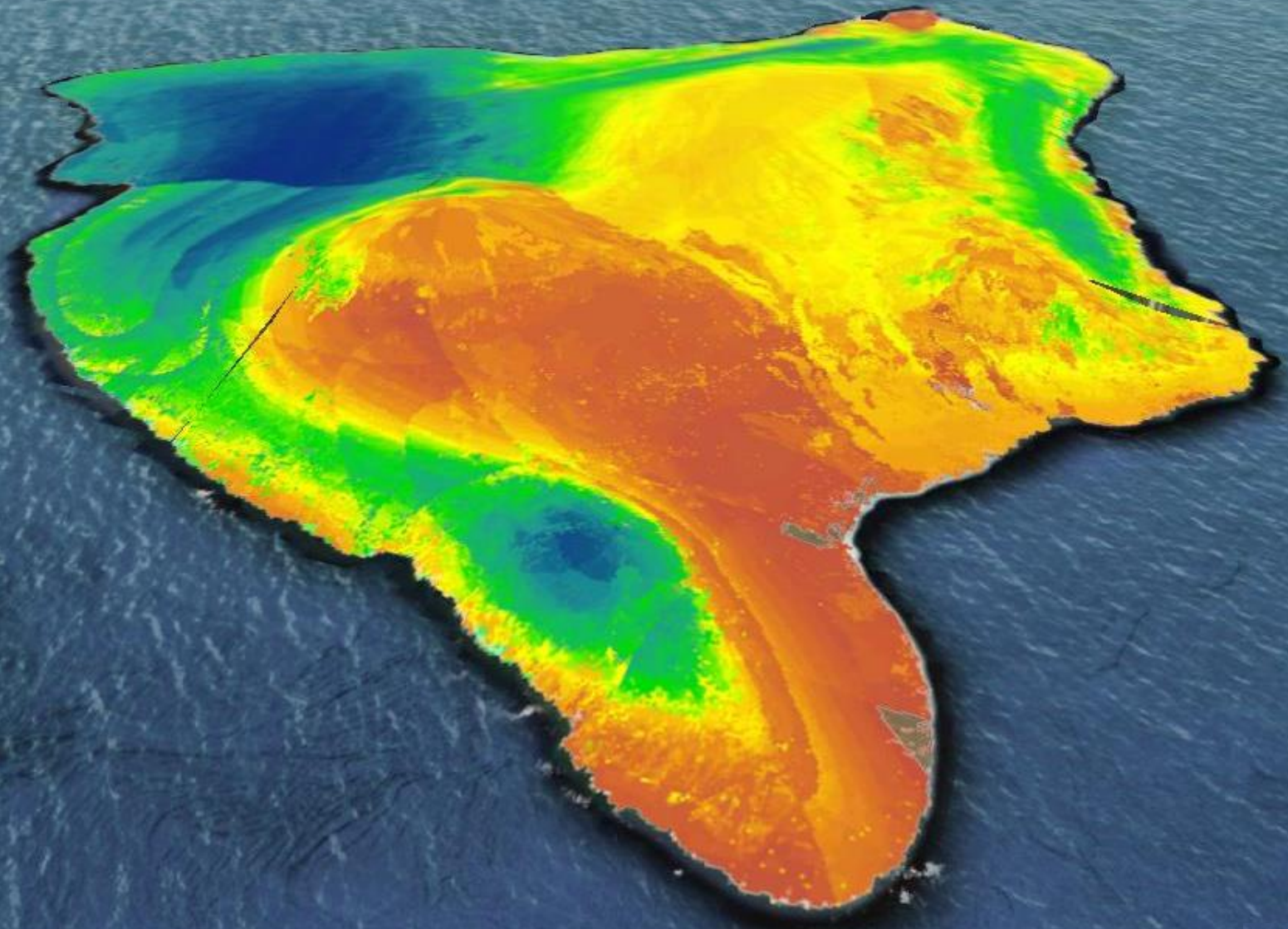


Photos: Forest and Kim Starr

Ongoing Recharge-Estimation Projects

- **Kauai** (USGS GWRP)
 - current and long-term average
- **Oahu** (USGS GWRP, CWRM, and HBWS)
 - current, predevelopment, future, long-term average, and 1900 to current (10-year periods) for Pearl Harbor area
- **Maui** (USGS GWRP, CWRM, and MDWS)
 - current, drought , and long-term average
- **Molokai** (OHA, DHHL, and MDWS)
 - 1940 to current (10-year periods)

Thank you



Ongoing Recharge-Estimation Projects

- **Kauai:**
 - current and long-term average (USGS GWRP)
- **Oahu:**
 - current, predevelopment , and future (USGS GWRP)
 - long-term average (CWRM)
 - 1900 to current (10-year periods) for Pearl Harbor area (HBWS)
- **Maui:**
 - current (USGS GWRP)
 - long-term average and drought (MDWS and CWRM)
- **Molokai:**
 - 1940 to current (10-year periods) (OHA, DHHL, and MDWS)

Ongoing Recharge-Estimation Projects

- **Kauai** (USGS GWRP)
 - current
 - long-term average
- **Oahu** (USGS GWRP, CWRM, and HBWS)
 - current
 - predevelopment
 - future
 - long-term average
 - 1900 to current (10-year periods) for Pearl Harbor area
- **Maui** (USGS GWRP, CWRM, and MDWS)
 - current
 - drought
 - long-term average
- **Molokai** (OHA, DHHL, and MDWS)
 - 1940 to current (10-year periods)